29. A method according to claim 25, wherein the second field of the non-reference frame is predicted using merely information from the second field of the reference frame.

30. A storage medium comprising a plurality of executable instructions which, when executed by a computing system, cause the computing system to implement a method according to claim 20.

31. A storage medium comprising a plurality of executable instructions which, when executed by a computing system, cause the computing system to implement a method according to claim 1.

REMARKS

This response is submitted to an Office Action received August 21, 2001, and in light of a telephone interview with the Examiner on November 5, 2001. In this response, claims 1, 12, 18, and 20 have been amended, as represented above and specifically denoted in Appendix A, to expressly abandon the amendments made in the last response and place the claims in form for possible appeal. In this regard, the amendments found herein broaden the claims. Accordingly, 1-31 claims are pending.

Applicant respectfully traverses the substantive rejections of claims 1-31, and continues to maintain the characterization of the Iu and Eifrig references introduced in previous responses. In addition to these "official" citations, the Examiner mentioned that the currently pending claims are unpatentable over U.S. Patent Application No. 09/116,382. If the Examiner wishes to withhold allowance based on Application No. 09/116,382, Applicant respectfully requests that

this be done formally so that such rejection can be formally addressed. In light of the amendments herein and the subsequent remarks, reconsideration of the above-captioned application is respectfully requested.

§102(b)/(e) Rejections

In section 3 of the Action, claims 1-31 were rejected under U.S.C. 102(b) as being anticipated by U.S. Patent No. 5,666,461 to Igarashi et al (the "Igarashi reference"). In section 4 of the Action, claims 1, 18, and 20 were also rejected as being anticipated by U.S. Patent No. 5,274,442 to Murakami et al. (the "Murakami reference"). In response, Applicant respectfully traverses the rejection of the claims.

The Igarashi Reference

The Igarashi reference is generally drawn to an encoder and decoder for dividing a picture into areas and deciding which of frame-based or field-based orthogonal transformation would be most efficient at reducing spatial redundancy in each area. Moreover, the encoder decides which of frame-based or field-based predictive encoding would be most efficient at reducing temporal redundancy in each area. Accordingly, the Igarashi reference teaches a field motion detector that detects inter-frame, field-based motion from at least one odd field *and* at least one even field of a previously encoded I or P picture. The Igarashi encoder then performs an additional step of predicting an error value for the averaging of the two field predictions. Referring to FIG. 3, for motion prediction of P picture macroblocks:

> ". . . the detector 21 detects motion between the current macroblock and macroblock sized areas *in at least two previously encoded fields, namely, the odd and even fields* of a previously encoded I or P

> picture. Also, the motion prediction error for a prediction obtained by averaging the two field predictions is obtained." (See col. 15, lines 16-26). (*Emphasis added.*)

For motion prediction of B picture macroblocks:

> ". . . the detector 21 detects motion between the current macrobblock and macroblock sized areas *in at least four previously encoded fields*, namely, a previously encoded temporally *past odd field*, a previously encoded temporally *past even field*, a previously encoded temporally *future odd field*, and a previously encoded temporally *future even field*. Also, the motion prediction error for a prediction obtained by averaging the two best predictions of the four previously enumerated predictions is obtained." (See col. 15, lines 26-35.) (*Emphasis added.*)

The Igarashi encoder then performs an additional frame-based motion prediction in which the odd field of a previously encoded frame is scanned by moving a macroblock-sized window across the frame one pixel at a time to find the windowed macroblock that is the most similar to the current macroblock being predicted. (See col. 17, line 60 through col. 18 line 16.) The entire procedure is repeated for the even field of the reference picture with respect to the current odd field pixels of the macroblock and then repeated for the even field pixels of the current macroblock with respect to each of the odd and even fields of the reference picture. (See col. 18, lines 17-21). A motion prediction decision circuit then decides which of frame-based motion prediction and field-based motion prediction of previously encoded data should be performed by frame memory. (See col. 15, lines 55-61.) A selector 24 then selects among the corresponding frame and field motion vectors, and supplies either the frame vectors or the field motion *vectors* (*plural*) to a block processing decision circuit, a frame memory, and a variable length encoding circuit. (See col. 15, line 62 through col. 16 line 4.)

The encoder of FIG. 3 is thus able to select which of frame-based and field-based orthogonal transformation is most efficient for a macroblock, and to independently select which

of frame-based and field-based predictive encoding is most efficient for the macroblock. (See col. 16, lines 26-30.)

Claims 1-31

In contradistinction to the teachings of the Igarashi reference, claims 1-31 are generally directed to a method and apparatus for simplifying field prediction motion estimation. Those skilled in the art will appreciate that, although the computationally intensive video encoding associated with the MPEG-2 standard provides high-resolution video imagery, its implementation typically requires one or more powerful, dedicated processor(s) (e.g., a microcontroller, an application specific integrated circuit (ASIC), a digital signal processor (DSP) and the like) to encode (or, conversely decode) MPEG-2 standard video data (e.g., to/from a DVD disk). Attempts to utilize the general purpose central processing unit (CPU) of a typical home computer for MPEG-2 processing has proven computationally prohibitive. (See Applicant's specification, page 5, line 15 through page 6, line 1.)

Accordingly, claims 1-31 are directed to simplifying the computationally intensive field prediction motion estimation associated with the prior art. In this regard, claim 1, for example, includes the features of:

> receiving a stream of data comprising at least a predicted frame and an anchor frame; and
> utilizing *even-parity* field prediction to predict content of each of a plurality of fields of the predicted frame *from corresponding fields* of the anchor frame. (*Emphasis added.*)

Well-settled case law requires that in order to anticipate a claim, a single reference must teach each and every element as presented in the rejected claim. In this case, Applicant respectfully asserts that the Igarashi reference fails to anticipate, disclose, or suggest to one

skilled in the art the required feature of utilizing *even-parity* field prediction to predict content of each of a plurality of fields of the predicted frame *from corresponding fields* of the anchor frame as presented , for example, in rejected claim 1. Even-parity is presented in Applicant's specification with reference to FIG. 12:

> "As shown in Fig. 12 two frames are presented an I-frame 1302 and a subsequent B-frame 1308. In accordance with the even-parity field prediction process of the present invention, the even field 1310 of B-frame 1308 is predicted from the corresponding even field 1304 of the temporally closest reference frame, i.e., I-frame 1302 in this example. Similarly, the odd field 1312 of B-frame 1308 is inter-frame encoded based on the content of the odd field 1306 of reference frame 1302." (Applicant's specification, page 20, line 19 through page 21, line 2.)

It should be noted that Fig. 12 depicts a *single* vector arrow from the even field of the I-frame 1302 to the even field of the B-frame 1308. Fig. 12 does not show any other vector arrow pointing to the even field of the B-frame 1308. Likewise, Fig. 12 depicts a single vector arrow from the odd field of the I-frame 1306 to the odd field of the B-frame 1312. Fig. 12 does not show any other vector arrow pointing to the odd field of the B-frame 1312. Thus, even-parity field prediction, according to Applicant's specification, means that a predicted even or odd field is predicted from, *and only from*, a corresponding even or odd field in a reference frame.

Despite the characterization in the Action, the passages, figures, and tables of the Igarashi reference cited in the Office Action (i.e., columns 7-9; Figs. 3-8, 10A-10C, and 18A-18B; and tables 1-4) merely describe the conventional, computationally intensive approach to motion estimation of using as much information as available to support encoding of each of the fields of a predicted frame. Thus, the Igarashi reference **teaches away from** Applicant's claims, which are directed to using as little information as possible to support encoding a field of a predicted

frame (always uses a single motion vector from a corresponding field in a reference frame). Indeed, as shown in Figs. 8 and 9 of the Igarashi reference, motion prediction for predicted fields always uses a computationally intensive estimation that involves deriving, selecting among, and then using a plurality of motion vectors from a plurality of sources.

The Murakami Reference

In section 4 of the Action, claims 1, 18, and 20 were also rejected as being anticipated by U.S. Patent No. 5,274,442 to Murakami et al.

The Murakami reference is generally directed to an adaptive blocking coding system that selects an effective blocking of a signal to be encoded using motion from both odd and even fields of a frame. (See col. 3, lines 47-50.) When an odd field is predicted, signals from previous odd and even fields are applied to an interpolator. After interpolation, the signals are sent to a selector to select the prediction signal with the minimum error signal power:

> "First, when the odd field K2 is inputted, the motion compensated prediction signal 204a from the odd field K1 of the preceding frame stored in the odd field memory 28 is provided to the selector 21. In the same manner, the even field G1 of the preceding frame stored I the even field memory 29 is provided to the selector 21as the motion compensated prediction signal 204C. The selector 21 compares these three kinds of motion compensated prediction signals 204a, 204b, 204c and the input image signal 201 to select the prediction signal which has the minimum error signal power." (Col. 11, lines 29-44).

The even field is predicted in the same way. (Col. 11, lines 45-55.) Even if the interpolator is not used, both odd and even fields are used to predict a field, and a selection process is added to the prediction:

> "However, it is also possible that the interpolation section 20 is not used as shown in Fig. 12. In this case, the motion compensated prediction signal is generated in the selector 21 on the basis of the preceding odd field K1 stored in the odd field memory 28 *and* the preceding even field G1 stored in the even field memory 29 and the selector 21 selects the prediction signal minimizing the error signal power in these two kinds of motion compensated prediction signals 204a, 204b. (Col. 11 line 61 through col. 12 line 2.)" (*Emphasis added.*)

The Murakami blocking image signal coding system is a computationally intensive scheme for motion prediction of a field. To predict one field, input from both odd and even previous fields are input into field memories, interpolated, and/or distinguished from each other by a selector.

Claims 1, 18, and 20

In contradistinction to the teachings of the Murakami reference, claims 1, 18, and 20 are generally directed to a method and apparatus for simplifying field prediction motion estimation. In this regard, claim 1, for example, includes the feature of:

> utilizing *even-parity* field prediction to predict content of each of a plurality of fields of the predicted frame *from corresponding fields* of the anchor frame. (*Emphasis added.*)

Well-settled case law requires that in order to anticipate a claim, a single reference must teach each and every element as presented in the rejected claim. In this case, Applicant respectfully asserts that the Murakami reference fails to anticipate, disclose, or suggest the required feature of utilizing *even-parity* field prediction to predict content of each of a plurality of fields of the predicted frame *from corresponding fields* of the anchor frame. Despite the characterization in the Action, the passages and figures of the Murakami reference cited in the Office Action (i.e., column 11 and Figs. 7 and 11) merely describe the same conventional,

computationally intensive approach to motion estimation as the Igarashi reference discussed above of using as much information as available to support encoding of each of the fields of a predicted frame.

Thus, the Murakami reference also teaches away from Applicant's claims, which are directed to using as little information as possible to support encoding a field of a predicted frame (always uses a single motion vector from a corresponding field in a reference frame). Conversely, the motion estimation described in columns 11 and 12 of the Murakami reference uses both the odd and even fields of a previous frame, and performs interpolation and/or selection steps on signals received from the odd and even fields to predict a single current field. Applicant's claims are directed to motion estimation that avoids the complexity and computational intensity described in the Murakami reference and the Igarashi reference of using multiple (odd and even) fields and various signal transformations to comprise and/or assist the prediction of a single field.

Neither of the single references (the Igarashi reference and the Murakami reference) cited by the Examiner teach each and every element of a rejected claim. Accordingly, Applicant respectfully requests that the §102(b)/(e) rejections of claims 1-31 be withdrawn.

§103 Rejections

In section 6 of the Action, claims 1-31 were rejected as being unpatentable over U.S. Patent No. 5,293,229 to Iu (the "Iu reference") in view of U.S. Patent No. 5,991,447 to Eifrig et al. (the "Eifrig reference") as set forth in the previous Office Action, and further in view of the Murakami reference. In response, Applicant respectfully traverses the rejection of claims 1-31.

The Iu Reference

The Murakami reference does not teach each and every element of Applicant's claims, as discussed above. This deficiency of the Murakami reference, in not anticipating Applicant's claims, is not cured by combination with the Iu reference and the Eifrig reference.

Applicant reiterates that the Iu reference is generally drawn to a video data compression system. More particularly, the Iu reference teaches a video encoding system which processes groups of fields of video data such that a predicted field is encoded using at least one anchor field *which has previously been encoded* and which is closer in time to the predicted field than any other *previously* encoded field (see, e.g., col. 2, lines 57-65; Figs 4 and 5). In this regard, Iu is illustrative of the prior art and the conventional approach to motion estimation of using as much information as available to support encoding of each of the fields of a predicted frame. With reference to Figs. 2-9, the Iu reference depicts a number of field prediction techniques, each of which illustrate that the field being encoded is predicted from a plurality of fields of multiple parity (i.e., even *and* odd). That is, in each of the illustrated example embodiments of the Iu reference, Iu discloses that field prediction of a field (e.g., P_6) is based on at least multiple prior fields of disparate parity (e.g., I_0 and I_1 of Fig. 4; I_1 and P_4 of Fig. 5; etc.). Indeed, with regard to the prediction of B-frames, Iu teaches the use of a plurality of previous and subsequent fields of multiple parity are used to predict a particular field of the B-frame (see, e.g., Figs 2-9, wherein each field of a B frame is predicted using at least a corresponding field from previous and subsequent reference (I and/or P) frames).

Contrary to the teachings of the Iu reference and the conventional video encoding practice of using as many sources of data as possible (i.e., even and odd fields of previous and

subsequent frames) to encode a predicted field, the claimed invention of rejected claims 1-31 merely relies on even-parity field prediction (i.e., only the corresponding like-parity field of a past *or* a future reference frame is used). In this regard, utilization of even-parity field prediction flies in the face of the Iu reference as well as conventional video encoding practice.

By specifically teaching the use of even *and* odd fields of *at least* past reference frames to predict content of a field of a predicted frame (see, e.g., Figs. 2-9 and associated text), Applicant respectfully asserts that the *Iu reference actually teaches away from* that which is claimed in rejected claims 1-31. By teaching away from the claimed invention of rejected claims 1-31, Applicant respectfully submits that the Iu reference cannot reasonably be interpreted as anticipating or rendering obvious such claims.

Without the need to further characterize the Eifrig reference, Applicant notes that the Eifrig reference is not cited as teaching, nor does it teach the limitations in the Iu reference identified above. More particularly, Applicant respectfully submits that the Eifrig reference fails to disclose or suggest the use of even-parity field prediction to predict content of a predicted field. Accordingly, Applicant respectfully submits that claims 1-31 are patentable over the Iu reference, alone or in combination with the Eifrig reference and/or the Murakami reference. Accordingly, Applicant respectfully requests that the §103(a) rejection of claims 1-31 be withdrawn.

Applicant maintains that none of the references, alone or in combination, introduced in this or previous Office Actions teach or suggest that which is claimed in pending claims 1-31. Accordingly, Applicant respectfully submits that claims 1-31 are in condition for allowance and earnestly awaits notice of their allowance.

In an effort to expedite prosecution of this matter, the Examiner is invited to call the

undersigned counsel for the Applicant to discuss any further issues preventing allowance of the currently pending claims.

Please charge any shortages and credit any overages to our Deposit Account No. 02-2666.

Respectfully submitted,
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Appendix A: Amendments

In the Claims:

Please amend the claims as follows:

1. (Twice Amended) A method for performing motion estimation comprising:

receiving a stream of data comprising at least a predicted frame and an anchor frame; and

utilizing even-parity field prediction to predict content of each of a[n] plurality of fields [even-field] of the predicted frame from corresponding fields [an odd-field] of the anchor frame[,] [and an odd-field of the predicted frame from an even field of the anchor frame].

2. The method of claim 1, wherein the content of each of the plurality of fields of the predicted frame are predicted merely from a corresponding field of the plurality of fields comprising the anchor frame, scaled by a dynamically determined motion vector.

3. The method of claim 2, wherein the motion vector is dynamically determined by measuring activity within each of the plurality of fields of the anchor frame.

4. The method of claim 1, wherein the predicted frame either precedes or supersedes the anchor frame based, at least in part, on the predicted frame type.

5. The method of claim 1, wherein each of the predicted and anchor frames contain interlaced video content or progressive video content.

6. The method of claim 5, wherein a first field of the predicted frame and the anchor frame comprises even-field content of the interlaced video content, and a second field of the predicted frame and the anchor frame comprises odd-field content of the interlaced video content

7. The method of claim 5, wherein a first field of the predicted frame comprises even-field content of the interlaced video content and a first field of the anchor frame comprises odd-field content of the interlaced video content.

8. The method of claim 5, wherein a first field of the predicted frame comprises odd-field content of the interlaced video content and a first field of the anchor frame comprises even-field content of the interlaced video content.

9. The method of claim 1, wherein one or more motion estimation vectors are generated for each of the plurality of fields of the anchor frame by measuring a sum of absolute differences.

10. The method of claim 1, wherein even-field interlaced video content of the predicted frame is predicted from even-field interlaced video content of the anchor frame, and odd-field interlaced video content of the predicted frame is predicted from odd-field interlaced video content of the anchor frame.

11. The method of claim 10, wherein the even-field interlaced video content of the predicted frame is predicted from the even-field interlaced video content of the anchor frame and a motion vector, wherein the motion vector is determined by measuring a sum of absolute differences within the even-field interlaced video content of the anchor frame.

12. (Twice Amended) An apparatus comprising:

a motion estimation circuit to receive a stream of data comprising at least an anchor frame and a predicted frame, and to utilize even-parity field prediction to predict content of each of a plurality of fields [an even-field] of the predicted frame from corresponding fields [an odd-field] of the anchor frame[, and an odd-field of the predicted frame from an even-field of the anchor frame].

13. The apparatus of claim 12, wherein the anchor frame used either precede or supersede the predicted frame depending on predicted frame type.

14. The apparatus of claim 12, wherein the motion estimation circuit measures activity content within each of the plurality of fields of the anchor frame to generate a corresponding plurality of motion vectors.

15. The apparatus of claim 14, wherein the motion estimation circuit predicts content of a first in the predicted frame from content of a corresponding first field in the anchor frame and a first field motion vector, and predicts content of a second field in the predicted frame from a corresponding second field and a second field motion vector.

16. The apparatus of claim 12, wherein the predicted frame and anchor frame are comprised of interlaced video content, wherein a first field of each of the predicted frame and the anchor frame contain even-field interlaced video content, while a second field of each of the predicted frame and the anchor frame contain odd-field interlaced video content.

17. The apparatus of claim 12, wherein motion estimation circuit generates a motion vector for each of a first and second field of the predicted frame by measuring a sum of absolute activity differences in a corresponding first and second field of the anchor frame.

18. (Twice Amended) A storage medium comprising a plurality of executable instructions which, when executed, causes an executing processor to implement a motion estimation function to utilize even-parity field prediction to predict content of <u>each of a plurality of fields</u> [an even-field] of a predicted frame from <u>corresponding fields</u> [an odd-field] of one or more anchor frames[, and an odd-field from an even-field of one or more anchor frames].

19. The storage medium of claim 18, wherein the motion estimation function generates a motion vector associated with each of the plurality of fields of the predicted frame based, at least in part, on a sum of absolute activity differences within each of the plurality of fields of the anchor frame.

20. (Twice Amended) A method for performing motion estimation comprising:

receiving a stream of data comprising reference frames and non-reference frames; and

predicting content of each of a plurality of [a first type of] fields in non-reference frames and select reference frames using information contained in merely corresponding [a second type of] fields of a past or subsequent reference frame.

21. A method according to claim 20, wherein the reference frames include I-frame and P-frame types.

22. A method according to claim 20, wherein the non-reference frames include B-frames.

23. A method according to claim 20, wherein select reference frames include P-frames.

24. A method according to claim 20, wherein the content of each of the plurality of fields of the non-reference frame are predicted from a corresponding field of the plurality of fields comprising the reference frame, scaled by a dynamically determined motion vector.

25. A method according to claim 20, wherein a first field of the non-reference frame and the reference frame comprises even-field content, while a second field of the reference frame and the non-reference frame comprise odd-field content.

26. A method according to claim 25, wherein the first field of the non-reference frame is predicted using merely information from the first field of the reference frame.

27. A method according to claim 25, wherein the first field of the non-reference frame is predicted using merely information from the second field of the reference frame.

28. A method according to claim 25, wherein the second field of the non-reference frame is predicted using merely information from the first field of the reference frame.

29. A method according to claim 25, wherein the second field of the non-reference frame is predicted using merely information from the second field of the reference frame.

30. A storage medium comprising a plurality of executable instructions which, when executed by a computing system, cause the computing system to implement a method according to claim 20.

31. A storage medium comprising a plurality of executable instructions which, when executed by a computing system, cause the computing system to implement a method according to claim 1.